FATE AN OPERATIONAL PLAN FOR FY 02 AND BEYOND

APRIL 2002

PREFACE

The FATE, Fisheries and the Environment, concept was introduced as a Fishery Oceanography initiative at a NMFS Leadership Council meeting held in Seattle, July 8, 1997. An ad hoc planning team was formed at that time, and over the next 5 years the committee, through a series of planning meetings and reports, more fully developed the FATE concept leading to the FATE FY 2002 Implementation Plan[1] and FY 02 Budget Initiative approved by Congress. All members of the original ad hoc planning team, plus an additional member from the NWFSC, currently form the FATE Steering Committee FSC (Appendix 1). The FSC determines by consensus how the FATE budget allocation shall be distributed among NMFS research nodes. The Steering Committee met at the Sheraton Four Points Los Angeles International April 29-30, 2002 to plan the operations of FATE in FY 2002 and beyond and developed the plan described therein.

[1]ANON, 2002. Fisheries and the Environment (FATE) Decadal trends in fisheries productivity, an FY2002 Fisheries Oceanography Implementation Plan, 12p.

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1. FATE LEADING PERFORMANCE AND ECOLOGICAL INDICATORS

FATE indicators are measures of decadal to interannual change in stock productivity and indicators of decadal change in the physical and biological structure of the ecosystem. They fall into three broad categories:

- *Indicators of the biological responses of living marine resources*: These indicate the response of stocks to changes in the structure and physical characteristics of the ecosystem. They include time series of somatic growth, reproduction, distribution (migrations and other movements, and latitudinal shifts of pelagic communities) and mortality.

- *Indicators of Ecosystem productivity*: These indicators are proxies for changes in the structure of the ecosystem. They are based on measurements of structure of fish and zooplankton communities, relative abundance of exploited and unexploited stocks, food habits of apex predators and other indicators of predator-prey relationships.

- *Indicators of physical processes*: These leading indicators shall consist of estimates or proxies for upwelling strength, transport, mixed layer depth, habitat temperature, eddy strength and persistence, and other physical properties of the ecosystem relevant to the dynamics of LMR.

The value of these indicators for specific regions and stocks shall be presented on the web site indicating if the current trend is increasing, decreasing, or steady. In addition, as FATE evolves new synthetic indices will be developed which will indicate patterns for the entire ecosystem, an ultimate measure of ecosystem health.

2. THE FATE RESEARCHER NETWORK

Central to the management of FATE is a basin-wide, coordinated research network with staff fully committed to facilitating the use of FATE information to improve stock assessments and other scientific evaluations needed for management. To assure these responsibilities are met a dedicated FATE researcher FTE shall be located at each node of the FATE network (see Implementation Plan for further details). The FSC determined by consensus the allocations of FATE FTE researchers for FY 02 and 03 as follows:

Funding Year	FATE Node	Special FATE Responsibilities
FY 02	SWFSC/PFEL	FATE website, and basin-wide physical indicators
FY 02	Hawaii	FATE basin-wide satellite products
FY 02	SWFSC/La Jolla	FATE Synthesis of region-wide indicators
FY 03	NWFSC/Seattle	
FY 03	NWFSC/Newport	
FY 03	AFSC/Seattle	
FY 03	AFSC/Juneau	

Each FATE researcher, in addition to developing indicators and facilitating their use in local stock assessments, has the additional responsibility of contributing to the integration and synthesis of the

information generated by the FATE network.

3 FATE PROPOSALS AND 2002 WORKPLAN

All funds remaining after support for FATE FTE researchers and program administrative costs, shall be allocated on a short term basis to NMFS and academic researchers to develop new FATE products (see Implementation plan). During the start-up period, at current levels of funding, unsolicited proposals for these research funds shall be from within the NMFS North Pacific Research Centers and coordinated by FATE regional representatives. Public Announcements of Opportunity were judged to be a poor model for involving academic researchers in FATE. Rather, the Fate Steering Committee (FSC) shall identify gaps and encourage proposals from academic scientists to fill these gaps. The FSC shall review all proposals and select the proposals to be funded that best meet the goals of FATE. Proposals, shall not exceed 3 pages (12 point font), and contain the following sections: *Principal Investigator(s),Laboratory, Background, Approach*, *Benefits* (stress how the information will be used to support stock assessments or help with other scientific evaluations needed for resource management and identify target species); *Deliverables* (be specific regarding dates of production of indicators, and maintaining updates); *Organizations* (identify the organizations involved; if academic researchers are involved, the percentage of funds allocated to them); and *Costs* (Total cost of the project and short explanation of how the money will be spent).

Proposers are advised to read carefully the Criteria for FATE Research proposals outlined below because FATE differs fundamentally from past fishery oceanography programs, and because funding limitations add additional constraints.

3.1 Criteria for FATE Research Projects

FATE is an iterative research program that continually evaluates an expanding array of ecological and oceanographic indices to be used to improve fishery stock assessments and scientific evaluations needed for resource management. The focus of the program is on the development, and evaluation of FATE leading ecological indicators *and performance indicators*, their application to practical fishery management problems, and a continuing responsibility to regularly update this information thereby providing current information to NMFS stock analysts

and the public. An important underlying theme of this work is that the collective performance of fishery stocks, and ecological indicators, throughout the North Pacific provides the holistic benefits of identifying decadal changes in the productivity of North Pacific stocks and shifts in ecosystem structure. The work is inherently collaborative between the three Pacific Fisheries Research Centers (ecosystem and shifts in ocean climate regimes are not bounded by NMFS administrative units), and the work must focus on the delivery of products useful for management related fishery problems from the start. The FSC defined the following criteria.

- *Preliminary short-term studies:* FATE shall support short-term research to evaluate variables which may be useful as leading ecological indicators. The work must clearly specify when the evaluation will be completed, the variables under consideration, the likelihood that the measurements upon which the indicators are based will be sustained in the future, and the specific benefits the delivery of the product to the management of a specific species.

- *Deliverables:* all projects (except preliminary short term studies) must identify the indicators or synthesis products that will be produced from the work when they will be delivered, and how often they will be updated. These project shall regularly post on the FATE website the indicators or synthesis products resulting from the research.

- *Long-term Ocean Observation Programs*. At current level of funding, FATE can not afford to support *long-term* biological and physical measurement costs at sea such as deployment of oceanic buoys, drifters, sustained plankton sorting and identification, sustained annual otolith increment reading, sustained charter vessel costs, although additional measurement programs are deeply needed. At present, FATE must depend on existing ocean observation programs of NMFS and other agencies and add value to such sea-based measurements. The first step in the implementation of FATE was to build in the analytical and synthetic capacity of the FATE team in all Fishery Science Centers of the Pacific in FY 02-03. In the second phase, as funding increases, FATE shall undertake sustained sea measurements to fill major gaps, to the extent funding shall allow. These measurement gaps may also be filled by the NMFS Stock Assessment Improvement Program (SAIP) or other NMFS or NOAA programs in the years to come.

- *Short-term Ocean Observation*: As a proof of concept study, FATE shall support short term ocean observation products or work up of collections from such past surveys. Such projects need to clearly identify: the assessment or management related benefits of such work to specific target species, the conditions and costs of continuing the measurements in the future; and the likelihood that such work will be sustained.

- *Fishery Oceanography Process Studies.* The focus of FATE is fundamentally different from fishery oceanography process studies, that is, the study of biophysical processes in the sea designed to improve understanding of the dynamics of living marine resources (Figure 1). Consequently, FATE does not directly support such studies. The focus of FATE is on delivery of North Pacific ecological and performance indicators useful for detection of decadal changes in stock productivity, shifts in ecosystem structure and other scientific evaluations.

Figure 1: Cartoon illustrates the difference between FATE and a typical fishery oceanography program. Note that the linkage to assessment or other scientific evaluations related to management are established early on, while in a traditional fishery oceanography they are undefined, as is who shall maintain the time series (dashed line).

3.2 Projects to be Undertaken in Initial Year of Work

We provide here a summary of the work planned for FY-02 organized by class of indicators. The work includes that of FATE FTE's (see Appendix, 5.3) as well as that funded by the short term research proposals approved by the FATE Steering committee (Table 1, and Appendix, 5.1).

Develop time series of Biological Response Indicators. The objective of this work is to develop a time series that indicate the response of stocks to changes in their ecosystem. Marine resources respond by changes in distribution or movements, somatic growth, the reproductive output, and reproductive success (recruitment). Time series of annual somatic growth will be developed for a variety of west coast species from salmon to rockfish. These will be produced by back calculated growth from existing unread otoliths, a powerful tool. They will monitor growth responses up to 50 years back from the time of collection and will be part of continuing collections taken by NMFS and other resource agencies. A new 20-50 year times series of the reproductive response of hake and market squid (production and distribution of larvae) will be produced using existing collections. Time series will be used to follow trends in the biological response to changes in the ecosystem and they will also be related to changes in the physical conditions of the habitat. For some species El Niño trends are as important as decadal variability. For example, the squid fishery collapses during El Niños, and warm water years are associated with strong hake year classes. None of these time series of biological responses to ocean climate are currently available, but all can be extracted from existing collections of biological materials (otoliths, preserved larvae) or existing data records, and all will provide time series of 20-50 years in extent.

In a more exploratory approach, FATE also supported short term, one-year studies to identify the

best physical indicators of recruitment for walleye pollock, Alaskan winter spawning flatfish, sablefish, and various California rockfish species. When identified, the suite of best physical indicators will become part of the key physical process indicators posted on the web site. Such exploration of data sets are an important but short term activity in FATE, constrained to the analysis of continuing data sets of sufficient length to detect decadal changes in ocean climate.

Develop Indicators of Ecosystem Productivity. Development of several measures of ecosystem productivity were supported by 2002 funding. They included zooplankton indicator species as measures of ecosystem productivity in Oregon waters (they seem particularly important for juvenile salmon and sablefish) and species assemblages as indicators of geographic shifts in pelagic communities in southern California. The data for these indicators are derived from existing and past plankton surveys along the west coast of North America. Time series of two very important ecosystem indicators will be developed using satellite imagery i.e., the position, and surface chlorophyl concentration of the transition zone chlorophyl front of the North Pacific. This front is the North Pacific corridor for trans Pacific migrations of albacore tuna, turtles, albatross, and other pelagic species. It shows major northern displacement during an El Niño affecting the migratory patterns of many important species across the Pacific as well as their feeding grounds. Such changes not only affect the dynamics of these populations, but affect the risk of undesirable bycatch of endangered turtles.

Develop Key Physical Indicators. An important responsibility of FATE is to adapt existing large scale physical indices to make them more meaningful for particular marine ecosystems and resources. To that end, in 2002 FATE will develop a Biologically Effective Upwelling Transport Index (BEUTI). BEUTI will refine the already useful upwelling index of PFEL, to include measures of water stratification, mixing, nutrient concentrations and primary productivity, thereby adapting the index to better fit specific mechanisms affecting resource dynamics. Similarly, the newly developed index NOI (Northern Oscillation Index) will be posted on the FATE web site. The NOI is similar to the SOI (Southern Oscillation Index) but gives a better fit to westcoast biological time series than the SOI because it includes north Pacific variability. (NOI is based on the pressure difference between Darwin and a high pressure area off the California coast instead of between Darwin and Tahiti).

Completely new indices will also be developed during 2002. They include the California Current Water Mass Index (CCmass) which will quantify the strength of transport in the coastal California Current. Interannual variability in this index will be an indicator of egg and larval transport along the entire coast, hence closely linked to recruitment, and the effectiveness of marine reserves as a regulatory measure. Another new index will be North Pacific Transport Index (NpacTrans) which will measure large-scale variability of transport across the North Pacific in an area called the West Wind Drift. Variability in this index will be related to trans Pacific migrations and an indicator of the source water for the California Current which affects productivity along the coast.

Web Page Development. A FATE web page (fate.noaa.gov) highlights the FATE concept and provides the source for FATE indices and other data products will be online by September 2002. The live access server will be the tool through which FATE data and indices will be disseminated.

FY-02 PROPOSALS

TABLE 1. FATE FY-02 PROPOSALS

Center	P.I.(s)	Title	FY-02 Costs
Alaska	John Helle	Adult salmon habitat/growth/survival index	59000
Alaska	Anne Hollowed	Index development and ecosystem monitoring	62400
Northwest	Michael J. Schirripa	Incorporation and evaluation of environmental parameters into the assessment of sablefish off the continental U.S. Pacific coast.	57500
Northwest	Michael J. Schirripa	Analysis of variable annual growth in Pacific hake, *Merluccius productus*	5000
Northwest	Bill Peterson	Zooplankton species abundance anomalies as indicators of ecosystem and climate change	50000
Southwest, La Jolla	Paul E. Smith Richard Charter	Ichthyofaunal indicators of ocean regime shifts	20000
Southwest, La Jolla	Richard Charter William Watson	Market squid paralarvae indicators of El Niño response	50000
Southwest, La Jolla	Paul E. Smith Richard Charter	Hake larval abundance and spawning center	75000
Southwest, Santa Cruz; OSU, Newport	Mary Yoklavich George Boehlert	Long-term indices of annual growth in long-lived groundfishes	76000
Southwest, Santa Cruz	Stephen Ralston	Scale of physical processes governing groundfish reproductive success	70200

4 ADMINISTRATION OF FATE

4.1 Chairpersons:

FATE is managed by consensus by a FATE Steering Committee (FSC) representing all NMFS fishery research groups in the Pacific. Two steering committee members, elected by the committee, serve as co-chairs of the steering committee and are responsible for arranging rapid responses to headquarters requests, scheduling and arranging meetings, and transfer of FATE research funds between NMFS Centers. Election of chairs and co-chairs for the next 4 years were as follows.

Period	Chair	Co-Chair
June 2002-2003	John Hunter	Jeff Polovina
June 2003-2004	Jeff Polovina	Bill Peterson
June 2005-2006	Bill Peterson	Ann Hollowed

June 2006-2007	Ann Hollowed	TBN

Co-Chair will act for the Chair during absences.

4.2 Web Site

PFEL/SWFSC shall manage the website for the FATE programs using data inputs from the AFSC, NWFSC, SWFSC and Pacific Islands Center. If feasible, the website www.fate.noaa.gov will be used for this website. For additional details regarding web site administration see Appendix III background document for April 2002 FSC Meeting.

4.3 Outreach

As FATE is a new and unique NMFS program, it is essential that the public, fishers, Councils, and NMFS administrators are familiar with FATE plans and objectives. To that end the FSC agree to:

- Develop a Power Point presentation on FATE. Frank Schwing (PFEL) shall assemble the presentation using submissions from all FSC members. These materials would be made available on the FATE web site so that presenters could obtain them for their presentation.

- Jeff Polovina, Rick Methot, and Anne Hollowed, agreed to make a presentation at their respective Management Council meetings.

- Presentations were also needed for NMFS Headquarters, NMFS Leadership council, various fishing and environmental groups.

- The FSC agreed that outreach to fishers and the public was an important function of the web site, and as a consequences it needs to be designed in a way that information is presented in a form that is easily assimilated as well as providing more technical information and data for the FATE network.

4.4 Meetings, Deadlines, and Administrative Details:

Proposals selected for FY 2002 funding must be revised according to the guidelines and resubmitted by the end of May, and those proposed for FY 2003 funding need to be submitted by the end of July. A FSC meeting to review FY-03 proposals, and develop a FY-03 budget, review a draft mission statement, and other administrative matters is scheduled for Sunday, September 22, 2002. The possibility of inviting East Coast NMFS Fishery Research Centers representatives to attend to familiarize them with the goals and objectives of FATE was discussed.

The FSC also recommended holding a workshop with invited participants from the NMFS and the academic community to discuss indicators, and run models that will use such information to provide an assessment of current state of the ecosystem. The central issue is to encourage academic scientists to work with the FATE team in adding value to FATE indicators by applying models to create a synthesis. ECOSIM was suggested as one such model.

5. APPENDIX

5.1 FATE Proposals Funded FY-02

Alaska Center

FATE FY2002 Proposal

Title: Adult salmon habitat/growth/survival index

Principal Investigator(s)/Laboratory: John Helle, NMFS, Alaska Fisheries Science Center, Juneau, Alaska

Background
The Alaska Department of Fish and Game (ADF&G) has collections of scales and size data taken from the mid-1960's to the present time from chum salmon in the major rivers and streams flowing into the Bering Sea from western Alaska. These scales have been aged but the growth parameters on the scales have never been measured. Early marine growth has been shown to be a proxy for survival in some studies and we intend to analyze growth and develop an index of salmon growth and abundance to compare to marine environmental data.

Approach
We have received from ADF&G a list of the scale collections from rivers and streams in western Alaska. We intend to contract with ADF&G to measure the distances to and count the number of circuli and annuli on scales from chum salmon in the Kuskokwim and Yukon Rivers and various streams in the Norton Sound area. Auke Bay Laboratory will provide the analysis of the data.

Deliverables
We anticipate receiving the scale measurement data by July 1, 2003 and we plan to complete the comparisons of the scale parameters and environment data by May 1, 2004.

Benefits
Chum salmon returns to western Alaska and Japan and Russia have been depressed for more than five years. All of these stocks utilize the Bering Sea for early rearing and some overwintering so there is ample reasons to suspect a common marine problem that is affecting survival. An analysis of growth indices from the scales of chum salmon could provide some clues to the causes of lower survival and hopefully also provide some indicators of environmental conditions in the Bering Sea that may prove useful in predicting brood strength of chum salmon.

Organizations
Alaska Fisheries Science Center, Juneau, Alaska

Costs
37 years of scale collections from 3 systems (Yukon and Kuskokwim Rivers and one stream in Norton Sound), count and measure circuli and annuli from 100 fish from each system, at $5 per fish: $55,500

supplies: $3500

Total: $59,000

FATE FY2002 Proposal

Title: Index development and ecosystem monitoring

Principal Investigator(s)/Laboratory: Anne Hollowed, NMFS, Alaska Fisheries Science Center, Seattle, Washington

Background

The Ecosystem Principles Advisory Panel recommended that Councils develop programs for broad-scale ecosystem research and monitoring program ("ECOWATCH") to observe ecosystem changes in a comprehensive manner. The FATE initiative fulfills several of the elements of an "ECOWATCH" program. Specifically, it is designed to improve our ability to identify and predict the response of fish to ecosystem change. The first step of FATE is to develop and maintain ecological indicators and to evaluate response of fish to these indicators in a comprehensive manner. The second step is for researchers to evaluate the predictive power of the indices to enable managers to develop reliable thresholds to harvest to prevent major human induced restructuring of marine ecosystems.

This proposal calls for additional personnel to expedite the development and evaluation of ecological indices and to identify methods for utilizing ecological information in making management decisions. Scientists will perform comparative studies with information from other regions.

In 2002 – 2003, personnel will evaluate three new indices: a) index of frontal regions in the eastern Bering Sea; b) indices of surface advection across the eastern Bering Sea shelf, and c) indices of water column structure on spawning biomass in Shelikof Strait. Retrospective analyses suggest that the first two indices hold promise for explaining temporal patterns in pollock and winter spawning flatfish recruitment (Wespestad et al. 2000, and Wilderbuer et al. In Press). The third index is being reviewed because of apparent shifts in the spawning distribution of walleye pollock in Shelikof Strait.

Approach

This proposal calls for personnel to: a) develop ecosystem indices, b) incorporate these indices into fisheries management advice and c) coordinate index development and index use with other FATE research nodes.

The individual hired to conduct this work will not work alone. He or she will augment existing research efforts on-going at all 5 science centers. This person will act as a liaison between AFSC and other regional science centers. The incumbent will help in the production of the first State of the North Pacific report. This individual will also work with AFSC and PMEL staff to evaluate the utility of using selected indices for use in stock assessment advice.

In 2002, we request funds to support a post-doctoral appointment. In 2003, AFSC requests a continuation of the activities above. In 2004, we anticipate that the post – doctoral scientist will transition to a full time FTE.

Deliverables

In the near term, research activities associated with this project include some or all of the following activities:

- Development of three indices

- Incorporation of indices into groundfish stock assessments. Evaluation of the reduction in uncertainty in recruitment forecasts achieved by the addition of ecosystem indices.

- Development of recruitment predictions based on ecosystem indices and evaluation of the accuracy of these predictions.

- Transfer of information from PMEL and AFSC to other research institutions and conduct basin wide comparative studies.

Benefits
Major progress towards development of an ECOWATCH program
New methods for incorporating ecosystem observations into stock assessment advice

Organizations
Pacific Marine Environmental Laboratory, and the Alaska Fisheries Science Center

References
Wilderbuer, T. K., A. B. Hollowed, W. J. Ingraham Jr., Paul D. Spencer, M. Elizabeth Conners, Nicholas A. Bond, and Gary E. Walters. In Press. Flatfish recruitment response to decadal climatic variability and ocean conditions in the Eastern Bering Sea. Prog. Oceanogr.

Westpestad, V.G., L. W. Fritz, W. J. Ingraham, and B. A. Megrey. 2000. On relationships between cannibalism, climate variability, physical transport and recruitment success of Bering Sea walleye pollock, *Theragra chalcogramma*. ICES J. Mar. Sci. 57(2):272-279.

Costs
FY2002
Contracts: $60,000 for one post-doc
Travel: $2,400 for trips to coordinate State of the North Pacific Document.

FY2003
Contracts: $70,000 for continuation of post-doc
Travel: $2,400 for trips to coordinate State of the North Pacific Document.

FY2003
Personnel: One FTE $142,000
Travel: $2,400 for trips to coordinate State of the North Pacific Document.

Northwest Center

FATE FY2002 Proposal

Title: Incorporation and evaluation of environmental parameters into the assessment of sablefish off the continental U.S. Pacific coast.

Principal Investigator(s)/Laboratory: Michael J. Schirripa, NMFS, Northwest Fisheries Science Center, Hatfield Marine Science Center, Newport, Oregon

Background

It is well known that environmental, climatic, and oceanographic variability can play a major role in determining annual fluctuations in the recruitment of marine fishes. Knowledge of how climate variability affects recruitment can help reduce the variance associated with current year estimates of recruitment, help predict future year class strength, as well as give insight to historic levels and patterns associated with "virgin recruitment". Little is known about these recruitment levels and patterns yet they remain a critical question in the determination of the status of the sablefish stock, which in turn directly drives annual management decisions. In this study, sablefish recruitment, past and present, will be examined for possible relationships to various oceanographic parameters that have been collected on an ongoing basis and that are readily available in a "raw" form.

The previous west coast sablefish assessment (Schirripa and Methot 2001) demonstrated what appeared to be a meaningful relationship between sablefish year class strength and anomalies of abundance for boreal shelf copepods. Although this relationship was quite revealing, the analysis suffered from a lack of annual observations of copepods for the entire time series of available recruitment estimates (1971-2000). Furthermore, the addition of estimates of spawning stock biomass to the regression model added very little or no explanatory power whatsoever. These results suggest that environmental processes may play a significantly larger role than spawning stock biomass in determining sablefish year class strength. If in fact variation in recruitment is driven primarily by environmental process and not by spawning stock biomass, then examination of the historical record of these processes may offer some insight into recent recruitment and what historical recruitment may have been like.

This study will attempt to discern relationships between sablefish recruitment and oceanographic and environmental variables and subsequently use these relationship to fit recruitment within the current population model. These relationships will also be used to help estimate recruitment in the current year, especially years when the continental shelf survey (triennial) is not conducted. Finally, these relationships will be used to hypothesize what historic (pre-fishery) levels of sablefish recruitment may have been and ultimately arrive at estimates of virgin spawning stock biomass.

Approach

In an effort to increase sample size of the independent variable (copepod abundance), several environmental variables, including sea level, will be investigated as an alternative. Sea level is often used as a proxy to quantify the southerly and offshore movement of water as a result of the California Current as well as the coastal upwelling index (Hickey 1998). Lower sea levels correspond to increased movement of water equatorward and offshore while higher sea levels correspond to decreased flows equatorward and offshore. Based on a significant relation between the copepod anomalies and sea level, it is hypothesized that variations in this equatorward and offshore movement that may in fact be driving the copepod anomalies, and consequently may be a similar measurement of the same processes.

Deliverables

- A compilation of time series of likely candidate environmental variables, verified for accuracy
- A compilation of recruitment time series of other important groundfish from previous assessments
- Preliminary conclusions regarding the level of significance of relations between these variables and sablefish recruitment
- An evaluation of potential generalized stock-recruitment models that incorporate an environmental parameter
- Should an environmental be found that adds explanatory power to the estimated recruitment trend, a generalized model will be fit and subsequently evaluated

Benefits

An understanding of the stock-recruitment relationship is essential to most assessments done on the west coast. This relationship dictates the estimates of MSY as well as the time to rebuild overfished stock. Furthermore, a more refined stock-recruitment would potentially lead to better short term recruitment forecasts. Finally, understanding how environment interacts with spawning stock biomass could lead to better estimates of virgin recruitment and/or unfished biomass.

Organizations

National Marine Fisheries Service, Northwest Fisheries Science Center at Hatfield Marine Science Center; Oregon State University (OSU); Cooperative Institute for Marine Resource Studies (CIMRS).

Costs

A 12-month graduate research assistant is requested to assist the PI in investigation of potential mechanisms for the relationships identified in the first year, and in development of models that will evaluate the consequences of these environmental linkages for current and alternative fishery harvest policies. Such a position will be filled by the OSU Cooperative Institute for Marine Resource Studies (CIMRS). Cost for a GRA at Newport, OR is $57,500 (including travel, equipment, supplies, and using overhead rate of 26%).

FATE FY2002 Proposal

Title: Analysis of variable annual growth in Pacific Hake, *Merluccius productus*

Principal Investigator(s)/Laboratory: Michael J. Schirripa, NMFS, Northwest Fisheries Science Center, Hatfield Marine Science Center, Newport, Oregon

Background

El Niño events disrupt the productivity and growth of different trophic levels across the eastern Pacific Ocean (Barber and Chavez 1983). These disturbances can leave marks on hard parts of fish that experience and survive such events. Natural marks on otoliths from environmental stresses have been observed in yellowtail and widow rockfish (Woodbury 1999) and Pacific whiting (MacLellan and Saunders 1995). Both of these studies linked reduced fish growth to the 1983 El Niño event. In 1997, the Northeast Pacific Ocean experienced one of the strongest El Niño events on record. It began in the spring of 1997 and lasted through the first half of 1998. The 1983 El Niño reduced Pacific whiting growth and we would like to determine if the same pattern held for the 1997 ENSO event. This study will expand on the work of MacLellan and Saunders (1995) to create a time series of Pacific whiting growth spanning from 1976 to 2000.

The Pacific whiting coastal stock is the most abundant groundfish in the California current system and represents one of the largest fisheries off the U.S. West Coast. The ability to successfully manage this commercially valuable species is of high importance. The proposed research will begin to provide a time series of growth data which can then be correlated to specific environmental fluctuations (Boehlert et al. 1989). This promotes a greater understanding of the events that ultimately cause fluctuations in Pacific whiting biomass and can provide predictive power to management decisions. This research can also provide further insight into Pacific whiting distribution, migration and annual growth patterns, which are pursuant to the objectives outlined by FATE.

Approach

Four hundred and fifty measurements will be taken from 150 otoliths. We will examine the 1996, 1995 and 1994 cohorts from the 2001 hydro-acoustic survey to determine if reduced growth occurred during the 1997 ENSO event. Expansion of the analysis would involve taking 4-5 line measurements from 150 additional otoliths (3600 measurements) from the previous 6 hydro-acoustic surveys (1983-1998) to provide the time series of growth dating back to 1976. Annual growth increments will be calculated each year by matching each measured increment with the year it was formed, the "age effect" removed, leaving only the year (i.e. environmental) effect and error term:

Growth = age effect + environmental effect + error

This statistical analysis will use a standard general linear model, similar to that as described in Weisberg and Frie (1987).

Deliverables

- A conclusion concerning the question of whether or not the latest El Niño event has effected hake growth
- A time trend of relative annual growth of hake by ages 1-4
- A working theory of how the annual migration of hake may or may not be related to that year's growth rate

Benefits

Individual somatic growth is directly related to the potential production of the stock. Knowledge of if/how the growth rate changes is necessary to correctly model the population. Documenting changes in growth are also necessary to validate proper ageing of the otoliths; if growth rate is assumed constant when it is in fact changing, small/old fish could be mistaken for younger fish based on length. Finally, observed changes in growth could act as a natural tag and help in the understanding of migrations patterns as their relation to environmental variables.

Organizations

National Marine Fisheries Service, Northwest Fisheries Science Center at Hatfield Marine Science Center

Costs

Ageing technician(s) currently under contract to NMFS through the Pacific States Marine Fisheries Commission will need to process 1050 otoliths that will take an estimated 300 hours of work to take growth increment measurements and perform data analysis. The total estimated cost is $5000.

References

Barber, R.T. and F.P. Chavez. 1983. Biological consequences of El Niño. Science. 222:1203-1210.

Boehlert, G.W., M.M. Yoklavich, and D.B. Chelton. 1989. Time series of growth in the genus *Sebastes* from the Northeast Pacific Ocean. Fish. Bull., U.S. 87:791-806.

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Weisberg, S. and R. Frie. 1987. Linear models for the growth of fish. *In* Age and growth of fish, edited by R. Summerfelt and G. Hall. Iowa State University Press, 544 pgs.

Woodbury, D. 1999. Reduction of growth in otoliths of widow and yellowtail rockfish (*Sebastes entomelas* and *S. flavidus*) during the 1983 El Niño. Fish. Bull., U.S. 97:680-689.

FATE FY2002 Proposal

Title: Zooplankton species abundance anomalies as indicators of ecosystem and climate change

Principal Investigator(s)/Laboratory: Bill Peterson, NMFS, Northwest Fisheries Science Center, Hatfield Marine Science Center, Newport, Oregon; and an unidentified post-doc from Oregon State University

Background

Zooplankton have been sampled on approximately 250 cruises at stations along the Newport Hydrographic Line during 12 years (1969-1973, 1983, 1996-present). Four stations have been sampled, 1, 3, 5, and 10 miles from shore. For one station (NH 05), we have calculated abundance anomalies for the 12-year record for the summer months (July-September). Copepod species were pooled into two groups: "cold water species" which dominate the waters of the Bering Sea shelf, the coastal Gulf of Alaska, British Columbia coastal waters and the Washington-Oregon coastal upwelling zone, and "warm water species" which dominate offshore and in coastal waters off central and southern California. Abundance anomalies were highly correlated with the value of the PDO. In samples taken during the cool regime (1970's and 1999-present, when the PDO was negative), 'cold water' species had anomalously high abundances, whereas samples taken during warm periods when the PDO was positive (mid 1990's), these cold water species had low abundances.

Our results for Newport are corroborated by changes in zooplankton species observed off Vancouver Island, Canada. Dave Mackas has shown that during the 1990-1998 period (warm ocean conditions and positive PDO), the copepod community was composed of an anomalously high biomass of warm water copepod species, but since 1999, cold water species had anomalously high biomass.

Approach

We will calculate anomalies of copepod species abundance for spring, summer, fall and on an annual basis, for all four stations sampled on the Newport line. In addition, an index of copepod production will also be calculated based on mean water temperature, temperature dependent copepod growth rates and species biomass. This index will be an integrated upwelling season value (May-September of each year). All anomaly and production index calculations will be updated seasonally and annually as new data are collected. Sampling along the Newport line is currently supported by the U.S. GLOBEC program through 2003.

Another goal is to develop a longer time series of copepod abundance by working with Dave Mackas (Institute of Ocean Sciences, Sydney, B.C., Canada). The idea is to attempt to join the older Newport Line data (1969-1973, 1983) with Dave's time series from 1985-present to produce a longer time series of copepod abundance anomalies for the northern California Current.

We will also work with FRAM stock assessment scientists (Methot, Schirripa, Helser, and Piner) to interpret possible relationships between copepod anomalies and recruitment of sablefish, whiting and other groundfish stock.

Deliverables

- Annual and seasonal copepod species anomalies for several coastal stations off Newport; by winter 2002.
- A 'Peterson-Mackas' northern California Current annual copepod anomaly index that would include the years 1969-1973, 1983, and 1985-present; by spring 2003

- A copepod production index calculated on an upwelling season basis for Oregon coastal waters; by winter 2002
- Deliver all indices to web master by winter 2002; post on local website as well
- At least one manuscript submitted for publication which describes temporal relationships between copepod anomalies and growth, recruitment and/or survival of at least one commercially-important fish species: either sablefish, whiting, rockfish, chinook, or coho salmon; by spring 2003

Benefits

The high correlation between the PDO and copepod species anomalies suggests that we may already have discovered an index that captures and detects decadal scale variability in ocean conditions and ecosystem structure. Further development of these anomalies for different seasons and on an annual basis is the chief benefit of our work since it contributes substantially to the overall FATE goal to "develop indicators of ecological and oceanographic change at the population and ecosystem level, and develop performance indicators that provide early warnings of major shifts in ecosystem productivity."

Organizations

Oregon State University, Hatfield Marine Science Center, Cooperative Institute for Marine Resource Studies

Costs

Contracts: $50,000 will be transferred to the Oregon State University Cooperative Institute for Marine Resource Studies to hire a post-doc for six months to carry out this work.

Southwest Center

FATE FY2002 Proposal

Title: Ichthyofaunal indicators of ocean regime shifts

Principal Investigator(s)/Laboratory: Paul E. Smith & Richard Charter, NMFS, Southwest Fisheries Science Center, La Jolla, California

Background

Three water masses (Subarctic-Transitional, Central, and Equatorial) and associated current systems (California Current, California Undercurrent, Nearshore Countercurrent) are present in the CalCOFI survey area. Short-term (ENSO) and long-term (ocean regime) changes in these systems are detected by CalCOFI oceanographic measurements. CalCOFI ichthyoplankton samples can provide unique information on these changes and on their biological consequences because they integrate the effects of physical features over time and space. Hare and Mantua (2000) found that "marine ecosystems of the North Pacific appear to filter climate variability and respond nonlinearly to environmental forcing." Thus, ocean regime shifts may be more clearly indicated by shifts in biological communities than by physical properties. Ocean regime shifts are important to fisheries management because of their effects on the productivity of coastal pelagic and groundfish stocks. Such shifts can occur very rapidly (within a year) but it may take a decade or more to realize that the annual productivity of a stock is varying around a new base line because of the shift in ocean climate. Fishery analysts need to know as soon as possible that such shifts have occurred since many of the steady state assumptions used in their models may be violated by long-term changes in the ocean environment. Water mass and current system changes associated with regime shifts are reflected in changes in the distribution and abundance of larval fish indicator species. Our ability to detect a regime shift is enhanced by the extraordinary number of larval indicator species in the CalCOFI time series.

Episodic events such as El Niño and La Niña, occurring at 2-7 year intervals, can have important effects on fish stocks and consequently on their management. CalCOFI time series will be used to detect and describe these effects. An example is the sudden appearance of large numbers of eastern tropical Pacific lanternfish larvae in the coastal sector of the survey pattern which indicates a northward advection by the unusually strong coastal countercurrent that develops during major El Niño events. An anomalously strong coastal countercurrent can advect larvae and pelagic juveniles of important fishery species such as sheepshead and ocean whitefish into the Southern California Bight from waters off central and northern Baja California. Information on potential strong year classes produced during these conditions is useful to managers of nearshore fisheries.

Approach

Analysis of changes in abundance and distribution of eggs and larvae of indicator species in spatial and temporal sectors of the CalCOFI survey pattern will be used to detect ocean regime shifts and the presence, extent, and intensity of ENSO (El Niño, La Niña) episodes. Recurrent group analysis has shown that species groups can be used to define ocean habitats within the CalCOFI survey area. For example, current work by Smith and Moser identify four clear indicators of coastal processes in Longfin Lanternfish, *Diogenichthys atlanticus,* an indicator of movement of central Pacific water mass into the Southern California Bight (SCB); Panama lightfish, *Vinciguerria lucetia,* indicator of transport of warm tropical water into the SCB (a strong El Niño signal); chub mackerel, *Scomber japonicus,* indicate transport of warm water communities near shore; and Mexican Lampfish, *Triphoturus mexicanus,* moderate advection of warm water communities from the South. Strong flow of the California Current from the north is best indicated by zooplankton

volume. Our approach would be to develop methods to automatically post on the web anomalies for most diagnostic species after the analysis of each quarterly cruise is completed (about 3 months after the cruise) and subsequently to develop assemblages of species as indicators of geographic shifts in pelagic communities. We believe the assemblages will be a more powerful tool but it shall require additional analysis. Future refinements could also include analyses of interannual changes in stage- or length-specific abundance of indicator species larvae which can yield information on residence time in specific sectors of the CalCOFI survey area. This approach would require measurement of preserved specimens, but the data can be used to estimate the timing, strength, and duration of climatic events.

Deliverables

- September 2003: complete software for automatically posting known indicator species from 1950
- September 2003: post on FATE web site annual anomaly pattern and maps for known indicator species for past 50 years
- September 2004: post on FATE web site a refined set of indicators

Benefits

The chief benefit of these ecological indicators is to provide evidence on a quarterly basis for geographic shifts in the pelagic community, indicative of changes in ocean climate. The focus is on the area occupied by the survey, but may be meaningful for the coast as a whole when linked to other FATE indices. While this information will probably not be used directly in stock assessment models, it will provide an ocean climate context and a historical framework for judging harvest guidelines.

Organizations

Southwest Fisheries Science Center, La Jolla Laboratory

Costs

Contracts: FY-02 - $20K to private contractor to write automatic web posting
FY-03 - $60K postdoc to refine assemblage indicators

FATE FY2002 Proposal

Title: Market Squid paralarvae indicators of El Niño response

Principal Investigator(s)/Laboratory: Richard Charter and William Watson, NMFS, Southwest Fisheries Science Center, La Jolla, California

Background

Market squid, *Loligo opalescens*, recently has become California's most valuable fishery and is managed under the Coastal Pelagic Species Federal Management Plan. Time series information is urgently needed to manage market squid, particularly during El Niño episodes. In the CalCOFI time series, data for fish larvae is currently up-to-date, but squid paralarvae have been counted and identified only since the summer of 1999 when it became clear that the NMFS would be responsible for management of market squid. A complete time series is needed to trace the dynamics of the stock through a number of El Niño episodes, thereby providing the information needed to understand the underlying mechanism for population collapses during El Niños and subsequent rapid recoveries. The solution proposed here is to establish a time series of squid paralarvae captured in CalCOFI surface samples from 1978 to the present and continue this time series with future annual CalCOFI surveys.

Approach

Squid larvae are most vulnerable to capture by manta (surface) net tows which have been taken on CalCOFI surveys since 1978. We will construct the time series by removing, counting, and measuring market squid paralarvae from Manta net samples and from 200 paired oblique net samples to determine a calibration factor for Manta and oblique net catches. This calibration factor will allow conversion of surface catches in the Manta net to catches for the entire upper column. Archived CalCOFI plankton survey samples are stored in the Scripps Institution of Oceanography Invertebrate Collection. Market squid paralarvae from approximately 2000 manta net samples from 1978 to1998 will be removed, counted, and measured by contract personnel. These data will be incorporated into the existing CalCOFI data base which includes station and tow data for all CalCOFI net tows, fish egg and larva data, and oceanographic data.

Deliverables

- September 2003: complete 10 years of the squid paralarval times series and post time series on web.
- September 2004: complete second 10 years and post on web (if funded by FATE)
- September 2005: produce and post time series of paralarval abundance estimates and quantitative characterizations of El Niño response and recovery

Benefits

No fishery in North America is more sensitive to El Niño episodes than the market squid. During the most recent El Niño, catch dropped from 80,000 tons to essentially zero. The fishery rapidly resumed after the close of the El Niño, with landings reaching their former level after two to four squid generations (1-2 years). These remarkable events need to be tracked closely with a measure of abundance that is independent of the fishery. Fishery dynamics (markets, availability, quotas, and economics) so confound squid landings data that it is impossible to clearly identify biological and environmental processes such as shifts in habitat preferences, recruitment failure, or rapid population growth. The proposed CalCOFI 21-year long time series for market squid holds the key to developing the needed understanding of their dynamics. Knowledge of the population dynamics of the fishery are needed so that we may advise managers on what precautionary measures should be taken to ensure a rapid recovery from an El Niño. In addition to understanding

squid dynamics during and after an El Niño, the proposed work will add 21 years to a new ongoing fishery independent index of abundance, the CalCOFI paralarval index of squid abundance. At least one fishery-independent index of abundance is needed for any stock assessment (Improving Fish Stock Assessments, NRC 1998). To be effective the time series of index values must be long enough to span major environmental shifts. As no other ongoing fishery-independent time series presently exists for market squid, the addition of 21 years of information is of immense value to stock assessments in the future.

Organizations

Southwest Fisheries Science Center, La Jolla Laboratory; and an outside contractor

Costs

Personnel	Sorting and identification of historic collections to generate 20 year time series, requires 4 person years of work at a cost of $50K per year per person, or $200K total cost
Contracts	FY-02 - $50K private contractor for sorting (SWFSC provided an additional $50K matching for 2002) FY03 - $100K private contractor for sorting

FATE FY2002 Proposal

Title: Hake Larval Abundance and Spawning Center

Principal Investigator(s)/Laboratory: Paul E. Smith and Richard Charter, NMFS, Southwest Fisheries Science Center, La Jolla, California

Background

Larval hake taken in the CalCOFI time series that are routinely identified each year could provide a useful fishery independent index of abundance. The time series begins in 1951, fifteen years before the onset of the fishery which began in 1966. Unfortunately, in 1985 five survey lines (extending from about Morro Bay to north of San Francisco) were eliminated from the pattern thereby diminishing greatly the value of the time series for hake because spawning is often concentrated along these central California CalCOFI lines. If these lines were to be reoccupied during the peak month of spawning (January) in the future, a new larval abundance index could be created that would indicate the extent the biomass may have declined from the virgin state (prior to fishing), and how it may change during different climate regimes. In addition, the geographic center of the spawn and the geographic location of its correlate, the 10°C isotherm at 100 m depth, could be determined indicating the extent of the southern spawning migration. The geographic center of spawning may affect the timing and extent of the northern migration to the feeding grounds off the NW coast and Canada.

Approach

We propose to reinstate for the January-February CalCOFI cruise, the 5 northern lines beginning in 2003. January and February are peak months of spawning of hake. The enhanced survey would provide a current day link to the 1951-1984 time series when those lines were occupied. We propose to examine the time series and develop the most precise and least biased index of abundance so that our level of understanding and past data will allow; thereby establishing a standard treatment of the data over the entire time series. Changes in gear to be considered include a shift from 140m to 200m maximum depth in 1969, shift from silk to nylon nets in 1966, a shift from ring net to bongo in 1978, and loss of the northern lines in 1985. A spawning area index or proportion of positive tows seems the most promising approaches. Existing data on hake vertical distribution will interpret effects of towing depth. The new index will be automatically updated and posted on the FATE web site each year. In addition, we shall compute the location of the 10°, 100 meter isotherm from CalCOFI, other regularly available data ,and the geographic center of the spawning distribution. Smith has determined that the 100m 10° isotherm at Point Conception is a good indicator of the geographic location of the center of the spawning habitat.

Deliverables

- January 2003: CalCOFI January-February survey extended to San Francisco
- May 2003: January 2003 distribution and abundance of hake larvae posted along with historic comparisons of larval time series and geographic distribution (basic data plots)
- September 2004: new derived indices of abundance, and spawning centers taking into account water temperature variation in occupation of fixed grid and other factors (this part of the work is contingent upon successful recruitment of a FATE FTE in La Jolla)

Benefits

The NWFSC carries out an annual stock assessment of the hake stock and also must estimate the fraction of the stock migrating into Canadian waters. The proposed indices would contribute to better understanding of the population dynamics and migration of hake and might be included in assessments if they have sufficient precision.

Organizations

Southwest Fisheries Science Center, La Jolla and Pacific Fisheries Environmental Laboratories, and the Northwest Fisheries Science Center

Costs

Contracts FY02 - $75K private contractor for sorting northern extension of CalCOFI January pattern

FY03 - $50K private contractor for sorting northern extension of CalCOFI January pattern and automatic posting of indices and maps on web

FATE FY2002 Proposal

Title: Long-term Indices of annual growth in long-lived groundfishes

Principal Investigator(s)/Laboratory: Mary Yoklavich, NMFS, Southwest Fisheries Science Center, Santa Cruz Laboratory, Santa Cruz, California; and George Boehlert, Oregon State University, Newport, Oregon

Background

Fish growth and its interannual variability represent an integrated picture of environmental and trophic conditions that vary from species to species. Retrospective time series of growth provide an opportunity to put contemporary growth in the context of past environmental variability. Traditional ageing groups determine age composition of fish stocks for incorporation into stock assessment and management. In this project we will develop long time series from selected species using alternative approaches. We will examine these time series as they relate to environmental variability over decadal time scales.

Approach

The approach involves analysis of otoliths of long-lived species following the model published on *Sebastes* (see Boehlert et al. 1989, Fishery Bulletin, U.S. 87:791-806). Careful back-calculation on sections of otoliths allows measurement of growth in the first several years of life. Our approach has been to measure growth in years 1 through 6 in fish of varying ages. As an example, an 80 yr old fish captured in 1980 would provide an index of growth in the years 1900 through 1906. Using a range of ages in a species, one can develop a long time series of the pattern of growth. This has been done for two species, splitnose rockfish *S. diploproa* and canary rockfish *S. pinniger.*

In the first year of this work, most effort will be placed in updating the time series from the above two species by approximately 20 years from the analyses done in the1980s. This will allow us to develop updated indices of growth and to conduct analyses to relate these time series to ocean variability. Related research is underway on Pacific halibut. In out-years we anticipate applying this approach to long-lived northern rockfish (e.g., rougheye rockfish or yelloweye rockfish) to provide a broader spatial component to examination of long-term growth indices. Should an Atlantic component of FATE develop, we have made the contacts needed to gather archived otoliths of *Sebastes* from the North Atlantic to likewise evaluate time series of growth there.

Deliverables

- The deliverables would consist of time series of growth.
- By the middle of FY03 we anticipate that time series of the two target species for the first year's work would be up and available on the website at least through the mid-1980s, and that subsequent years would be posted as data are validated.
- By the end of the first year, a publication would be prepared for submission to a journal.
- We would also work to develop approaches to provide annual or biannual updating of the time series to the FATE website through ageing units in NMFS.

Benefits

The indices of growth developed in this manner provide time series that are longer than records of catch or production presently available -- those in Boehlert et al. (1989) extended back to about 1935 for *S. pinniger* and about 1915 for *S. diploproa*. Early versions of FATE planned to develop these growth indices for many species along the west coast and Alaska, and if possible, for the same species in different parts of their range. Comparison of the growth patterns with environmental variability, much like the comparison of year class strength among diverse species, can lead to new insights about how fish respond to environmental variability on long time scales. Questions about how fish growth varies within regimes, the phasing of growth changes with regime shifts, how growth is affected by exploitation and stock size, and how ecologically different species respond can all be addressed using growth as an integrative biological feature.

An important feature of this project will also be linking current measurements to those earlier in the time series. Because growth estimates early in the time series typically come from very old fish, we must evaluate the degree to which early growth is linked to age (or, viewed in another way, whether rapid early growth is linked to reduced longevity). Year class growth estimated from young fish otoliths collected in the early 1980s are now over 20 years older, allowing different point estimates of the same year class growth. This will allow us to determine the linkage of early growth with age, which will be important to the validity of routine updates of the time series (and must be done with young fish).

Organizations

Southwest Fisheries Science Center, Santa Cruz Laboratory; and Oregon State University. All of the first-year funds will go to Oregon State University.

Costs

- FY02 $76K. The principal cost will be for personnel time for a research associate at OSU. The remainder will be for contribution to costs of equipment, supplies, and travel.
- FY03 $84K. If this program is supported beyond the first year, additional species will be analyzed and the costs will be for personnel and travel.

FATE FY2002 Proposal

Title: Scale of physical processes governing groundfish reproductive success

Principal Investigator(s)/Laboratory: Dr. Stephen Ralston, NMFS, Southwest Fisheries Science Center, Santa Cruz Laboratory, Santa Cruz, California

Background

The Santa Cruz (formerly Tiburon) Laboratory of the Southwest Fisheries Science Center has conducted an annual 30 day mid-water trawl survey off central California since 1983. The purpose of the survey has been threefold: (1) to develop a time series of the abundance of young-of-the-year pelagic juvenile rockfish (*Sebastes* spp.) for use as a pre-recruit survey in groundfish stock assessments, (2) to determine the factors responsible for interannual variability in reproductive success within the genus, and (3) to enhance our understanding of processes that structure biological communities within the California Current ecosystem. To date, time series of pre-recruit abundance have been used successfully in stock assessments of bocaccio (*Sebastes paucispinis*), widow rockfish (*S. entomelas*), chilipepper (*S. goodei*), and Pacific whiting (*Merluccius productus*). The information has allowed stock projections to be based upon explicit estimates of impending recruitment in the near term. Likewise, it is apparent that on broad spatial scales there is coherence in the recruitment of Pacific coast groundfish stocks. The mechanism underlying these correlated recruitment patterns, based upon an ongoing analysis of the data, is believed to be large scale flow variations in the California Current system. An apparent change in the ocean environment that occurred between 1998 and 1999 has led to increased reproductive success of many rockfish species.

Approach

We propose to devote more study to the relationship between physical forcing and groundfish recruitment strength using information gathered during the 19 years of the Santa Cruz Laboratory survey. Of particular interest is the relationship between pelagic juvenile rockfish abundance patterns and the Pacific Decadal Oscillation (PDO) and other low frequency signals. In addition, spatial correlations in recruitment can be identified by applying distinct age-structured stock assessment models to port-specific age composition data (e.g., widow rockfish) and comparing time series of recruitment. Lastly, opportunities also exist to conduct process-oriented sampling aboard the R/V David Starr Jordan to enhance our understanding of how physical variability in the ocean leads to biological variability in the distribution and abundance of the fishes and invertebrates encountered during the survey. This work will be conducted by a postdoctoral candidate hired through the University of California at Santa Cruz working under the guidance and supervision of Dr. Stephen Ralston (Research Fishery Biologist).

Deliverables

- Indices of year-class strength of various groundfish, including Pacific whiting, bocaccio, widow rockfish, yellowtail rockfish, chilipepper, and shortbelly rockfish (available in November of birth year).

- Description of hydrographic conditions during the peak of the upwelling season (May-June) along the central coast and how the physical topography influences the distribution and abundance of young-of-the-year pelagic juvenile groundfish (available in March of the year following birth).

- Analysis of port-specific recruitment trends of widow and yellowtail rockfish, including a synthesis of regional scale recruitment variability (completion of first year of funding).

Benefits
Indices of annual groundfish reproductive success have been used successfully in stock assessments and provide an explicit basis for projecting stock abundance into the future. Developing an understanding of the spatial scale of events responsible for interannual variation in recruitment will focus attention on the appropriate attendant physical processes.

Organizations
Southwest Fisheries Science Center, Santa Cruz Laboratory, Groundfish Analysis program; and the Department of Ocean Sciences, University of California, Santa Cruz.

Costs

Personnel (salary, benefits, & overhead)	$62,200
Contracts	–
Travel	$5,000
Equipment (computer)	$3,000
Supplies	–
Total:	$70,200

5.2 FATE Steering Committee

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5.3 FATE Background Document for April 2002 Steering Committee Meeting

Fisheries and the Environment (FATE)

FY-02 STEERING COMMITTEE MEETING

Los Angeles
April 29-30, 2002

1. FATE Common Program Elements

A. FATE Web Page and Data Management

The overall goals of the data management component of FATE are to: (1) assure the widest possible dissemination and utility of the ecological indicators developed in FATE, and (2) seek improvement in the manner that environmental variability is utilized for applied aspects of fisheries such as stock assessment and management. Even though the development and proof of the concept of FATE indices may take some time, an early 'success story' will be the development of the FATE web page, and the on-line serving of data sets and data products to scientists and managers. The web page will also serve as an effective conduit of communication of the activities and progress of the FATE program, and link it with other relevant research activities.

PFEL will be responsible for data management for the FATE program. The development and maintenance of the FATE web page will also be done at PFEL by permanent staff and contractors. Data management will be handled initially by individual investigators, who may maintain individual web pages as well. However, in the first year of this program PFEL will develop a centralized web site for the unified dissemination of FATE data and indices. This will be done principally through the PFEL Live Access Server (LAS) for environmental data. FATE will have a dedicated web page with access to the indices and any ancillary data developed in this program. Descriptions of the indices and their derivations will also be on the web page, along with links to other environmental data appropriate for fisheries applications.

In addition to its research role, PFEL has a long history of providing environmental data products tailored to fisheries research and management applications. PFEL derives a number of well-known environmental data and index products from the Navy's FNMOC data and routinely distributes these data to researchers at many state and federal laboratories, as well as to academic and international researchers. The coastal upwelling index, which reflects the strength of wind forcing on the ocean, has been used in many studies of the effects of ocean variability on the reproductive and recruitment success of fish and invertebrate species. New developments in web-based product delivery will be continued, such as the implementation of the PFEL LAS.

BUDGET	FY02	FY03	
Contract Personnel	$36k	$44k	
Computer Equipment	$12k	$ 4k	
Network Infrastructure		$ 2k	$ 2k
	$50k	$50k	

Budget Justification

Contract personnel will develop elements of LAS for FATE, modify and input FATE data sets and indices, and maintain these data bases. They will be hired through JIMAR and other contractors.

Computer equipment will include a desktop and peripherals in year 1 for serving FATE data, and an upgrade in external storage in year 2 for expanding the FATE data base.

Network infrastructure will include upgrades to the PFEL web bandwidth.

B. FTEs

i) PFEL FATE FTE

Position description & Duties

The person filling this position will be a formally trained oceanographer, capable of reducing, analyzing, and interpreting temporal and spatial patterns of atmospheric and oceanic variables from observational and model output large data sets, in the context of the fundamental processes of environmental variability and climate change. This individual will be the key scientist at PFEL involved with the R&D of regional and large-scale atmospheric and oceanic indices of environmental variability that indicate ecosystem change of significance to marine fish populations. This individual will interact with scientists at all FATE nodes to help customize indices for a variety of species. They will also be responsible for the generation of these indices. Because of the great importance of developing and applying indices that account for the mechanisms that directly affect and are responsible for ecosystem variability, this individual will focus primarily on research to evaluate the processes by which climate change is reflected in marine ecosystems, and ensure that the indicators developed and disseminated by FATE will be well-located in the context of the physical mechanisms of climate variability. This individual will work closely with the satellite oceanographer and fisheries biologist FTEs, and within PFEL with the data management and web design efforts.

Duties will include:

- Conducting research on the processes and mechanisms of climate variability that affect the regional and large (basin)-scale signals of the ocean and its ecosystems and populations.
- Developing and validating indices that characterize and summarize regional and large-scale physical variability of importance to marine ecosystems and their fish stocks.
- Working jointly with oceanographers within and outside of FATE to assess observational and model-based physical, chemical, and biological data sets for their utility as potential leading indicators of environmental variability on regional and large scales.
- Working jointly with FATE satellite oceanographers to develop, validate, and distribute indicators of environmental variability based on remotely sensed data products.
- Working jointly with FATE fisheries oceanographers and biologists to test the utility of process-based indices of physical environmental variability as performance indicators of variability in commercially important marine fish populations.
- Working jointly with the FATE data management and web design personnel to incorporate indices into the FATE data base in a timely and efficient manner, and making these indices readily accessible to scientists and resource managers.

ii) **FATE LA JOLLA FTE**

A FATE FTE will be used at the La Jolla Laboratory to provide the environmental linkage and analysis for Division stock assessments. The La Jolla Fisheries Resources Division does not have the human resources nor the expertise to add environmental linkages to stock assessment as

prescribed by FATE program without this FTE. The FTE will blend the skills of mathematical modeling of populations and the environmental analysis. In the first year working with the FATE CENTER, Monterey, CA and in close collaboration with the Pacific Fishery Management Council, Coastal Pelagics Species Team; the La Jolla FTE will develop a new environmentally based harvest formula for Pacific sardine based on a set of the most relevant set of environmental indices. This is a top priority project (described below) which will be the focus of the first year's work.

Strengthening the environmental basis for sardine harvest guidelines.
Background: That over the last hundred years, the Pacific sardine stock increased when relatively warm-water ocean conditions persisted and declined under cold water conditions is well established. Consequently, sardine are managed using environmentally-based harvest guidelines. A harvest formula is applied (Amendment 8 of the Coastal Pelagic Species-Fishery Management Plan, 1998) that varies the recommended harvest based on a fraction derived from the running average sea-surface temperature at Scripps Pier, La Jolla, California during the three preceding years. The formula was intended to maintain relatively high and consistent catch levels over multiple ocean climate regimes. Although the exploitation fraction of the population set by this temperature rule has held at consistently 15% since inception, recent declines in sea-surface temperature (1998-2001) may invoke substantial environmentally-based reductions in the exploitation fraction as early as the 2003 sardine fishing season. Advanced fishery modeling and simulations were used to develop the guidelines, and the work was a major advance in fishery science because, even to this day, few fisheries management schemes take into account decadal variability in fish productivity. However, the formula lacks the environmental sophistication proposed by FATE. Thus, future changes in the harvest fraction, based on the present formula, may not be justifiable because of the lack of sophistication and potential biases in the environmental evidence on which the harvest formula is based. Recent increased scrutiny and controversy over this harvest formula has revealed that the use of a single simple water temperature measurement as a proxy for shifts in ocean climate is risky. For example, minor changes in temperature recording procedures that occurred over the years might have economic consequences for the fishery. Clearly, a composite of indicators as proposed by FATE is a sound approach. Using sets of indicators to monitor trends is standard practice in economics, but such a sophisticated information was not available to the fishery scientists who devised the harvest formula. Fishery environmental-based assessment is a new frontier in fishery science and the central mission of FATE. Thus, as a first year FATE product, we propose to develop and evaluate an improved harvest formula for sardine based on a more sophisticated and robust set of environmental indicators, and to post these indicators on the web site along with the new harvest formula (after formula review and approval by the Council) so that fishers can track how current year environmental events may effect next years harvest allocation.
Approach: Working cooperatively with PFEL, a new suite of indicators would be evaluated with the objective of developing a more robust interdecadal measure of sardine productivity on which to base a harvest policy. The approach would be simulation modeling following the work of Jacobson and MacCall's earlier work.
Benefits: This work involves improving the environmental index already used for calculating the harvest of sardine in the Coastal Pelagics Species FMP, and hence is directly tied to annual sardine assessment. Strengthening the environmental science supporting a harvest guideline strengthens management policy based on the guideline, and reduces controversy and risk of litigation.
Organizations: SWFSC
Costs: This work would be a first priority project for the SWFSC FTE, as it would be extremely difficult to find a contractor willing and able to produce a useful product.

iii) **Pacific Islands Fisheries Science Center FATE FTE**

Duties and responsibilities

The FTE at the Honolulu Laboratory will provide much of the satellite remote sensing data analyses and tool development to the FATE team. The Honolulu Laboratory has had considerable success in using satellite remotely sensed chlorophyll, sea surface height, sea surface temperature, and surface winds to describe oceanic habitat critical to marine resources on both regional and basin scales (Polovina et al. 2000, Polovina et al. 2001, Seki et al. 2001, Polovina et al. In Review). We have skills in using satellite remotely sensed oceanographic data to monitor mesoscale features including cyclonic and anti-cyclonic eddies, geostrophic currents, Ekman currents, convergent and divergent fronts. We also have skills in using satellite remotely sensed data to monitor basin-scale features including the shape and position of the subtropical and subarctic gyres, position and speeds of major oceanic currents, gyre chlorophyll densities, etc, and temporal indices representing the principal modes variation in these basin-scale features.

The FTE at the Honolulu Laboratory will develop and produce maps and indices from satellite oceanographic data on two scales. In cases where the dynamics of oceanic habitat is critical to the population dynamics of a specific resource, then the maps and indices will be regional, focused on specific mesoscale features. However, a real strength of the satellite remotely sensed data is it's broad spatial coverage and the second scale of focus will be on maps and indices addressing basin-scale dynamics to produce a description of the physical and biological state of the North Pacific.

References:

Polovina, J. J., G. H. Balazs, E. A Howell, D. M. Parker, M. P. Seki, and P. H. Dutton. In Review. Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. *Can J. Fish. Aquat. Sci*

Polovina, J.J.,E. Howell, D.R.Kobayashi, and M.P.Seki. 2001. The Transition Zone chlorophyll front, a dynamic global feature defining migration and forage habitat for marine resources. *Progress in Oceanography*(49)1-4:469-483.

Seki, M. P., J. J. Polovina, R. E Brainard, R. R. Bidigare, C. L. Leonard, and D. G. Foley. 2001. Biological enhancement at cyclonic eddies tracked with GOES thermal imagery in Hawaiian waters. *GRL*:28(8):1583-1586.

Polovina, J.J.,E. Howell, and M. P. Seki. 2000. Satellite ocean color sensors detect biological change in mid-latitude North Pacific, 1997-2000.*EOS* AGU 81(44)p.519.

2. Proposals for Opportunity Funds

Alaska Center
- Recruitment Index For Crab And Flatfish FY03
- Recruitment Index For Walleye Pollock FY02
- Index Of Frontal Boundaries In Gulf Of Alaska And Southeast Bering Sea FY 2003, FY2004
- Index Development And Maintenance Support: FY02, FTE in FY03

Northwest Center
- Incorporation And Evaluation Of Environmental Parameters Into The West Coat Sablefish Assessment FY02, 03
- Analysis Of Variable Annual Growth In Pacific Hake, Merluccius productus FY02, 03
- Zooplankton species abundance anomalies as indicators of ecosystem and climate change FY02, 03
- Continuation of the Newport Long Term Observation Program (a contribution to a coast-wide network of observation programs). Development of a euphausiid biomass index (for whiting and rockfish management); development of a *Neocalanus plumchrus* anomaly index (for sablefish management). FY03
- Development of a biologically effective upwelling index for the coastal northern California Current. FY02, 03
- Development of an ichthyoplankton index FY02, 03
- Using stable isotope ratios of groundfish otoliths to examine growth across climate regimes FY02
- Two FTE at Northwest Fisheries Science Center FY03

Pacific Islands Center
No proposals submitted

Southwest Center
- Habitat Specific Squid Spawning Temperature Index. FY03
- Ecosystem health and shifting baselines. FY02, FY03
- Ichthyofaunal indicators of ocean regime shifts. FY02, FY03
- Reproductive Response of market squid to El Nino FY02, FY03
- Hake larval abundance index and spawning center. FY02, FY03
- The Biologically Effective Upwelling Transport Index FY03
- Long-term Indices of annual growth in long-lived groundfishes FY02, FY03
- Physical Forcing and Indices of Rockfish Recruitment Strength in the California Current FY02, FY03

Summary Budgets

FY02, page 36
FY03, page 37

5.4 Agenda for April 2002 Steering Committee

Fisheries and the Environment (FATE)
Planning Meeting, 29-30 April, 2002
Los Angeles

Monday, 29 April 2002

Purpose of Meeting	*Boehlert*	*0900*
Background and Purpose of FATE	*Hunter*	*0915*
• *Criteria for project selection*		
Program Resources and Initial Allocation	*Discussion*	*0935*
• *Draft Spending Plan*		
• *Common Program Elements*		
• *Mechanisms for funding allocations*		
• *Selecting research areas and partners*		
• *Program deliverables*		
Break *1030*		
Program Priorities and Perspectives	*(10 min each)*	*1050*
NMFS/HQ	*Cyr*	
Alaska Center	*Hollowed/Helle*	
Northwest Center	*Peterson/Methot*	
Pacific Islands Center	*Polovina*	
Southwest Center	*Hunter/Schwing*	
Plans for Common Program Elements		
Program Management and Coordination	*Discussion*	*1140*
Data Management and Web Page	*Schwing*	*1210*
Lunch *1230*		

Plans for Common Program Elements *(continued)*
FTEs 1400

- *Remote sensing* — *Polovina*
- *Large scale biophysical indices* — *Schwing*
- *Biophysical resource modeling* — *Hunter*
- *Future FTEs* — *Discussion*

Proposals for FY 2002-3 Opportunity Funding *(brief project descriptions)*

Alaska Center	*Hollowed/Helle*	*1445*

Break *1515*

Northwest Center	*Peterson/Methot*	*1535*
Pacific Islands Center	*Polovina*	*1605*
Southwest Center	*Hunter/Schwing*	*1635*

Plans for Day 2 *1705*

Adjourn for Day 1 *1730*

Tuesday, 30 April 2002

Allocating Opportunity Funding

- *Ground rules* — *Discussion* — *0830*
- *Projects in light of FATE priorities* — *0900*
- *Budgets and budget strategy*

Break *1000*

Allocating Opportunity Funding *(continued)*

- *Finalizing FATE 2002 budget allocations* — *1020*

Lunch *1200*

Planning FATE's future *1330*

- *FY 2003-4 budget projections* — *Cyr*
- *FY 2003-4 priorities* — *Discussion*
  - *FTE requirements*
  - *expansion to other Centers*
- *Coordination and program harmony*
- *Deliverables ("FATE Accomplishments" and tracking progress*
  - *Indices*
  - *Ecosystem Status Reports*

Break *1500*

Next Steps *1530*

Adjourn *1600*

Participants

Alaska Fisheries Science Center
Jack Helle
Anne Hollowed

NMFS HQ, Office of Science and Technology
Ned Cyr

Northwest Fisheries Science Center
Rick Methot
Bill Peterson

Southwest Fisheries Science Center
George Boehlert (short timer, for historical perspective)
John Hunter
Frank Schwing

Pacific Islands Fisheries Science Center
Jeff Polovina